

Development and Integration of Coastal Surveillance Radar System over four seas

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ABSTRACT

In the last decade surveillance implementations get more interest due to the increase of vessel traffic and at same time increase of terrorism, smuggling activities, and illegal immigration activities on waterways. The EU regulations and combat against criminalism is on the uppermost challenges at the Turkish maritime borders which leads to a national initiatives in maritime surveillance with the goal of national security in four seas in relation to the geographic location of the country. The Coastal Surveillance Radar System (CSRS) provides situational awareness with adequate radar coverage of the coasts, territorial waters and exclusive economic zones of Turkey and create a defined maritime picture supported by data received from radars, electro-optical sensors and some other military and ministerial institutions related to coastal security and sea traffic. The CSRS aims to increase cooperation level of military and ministerial institutions and organizations in charge of coastal areas of Turkey, and enhance efficiency of reconnaissance, patrol, and search and rescue activities.

Keywords: coastal surveillance radar system, maritime border, patrol, and search and rescue

1. INTRODUCTION

The Coastal Surveillance Radar System (CSRS) Project aims at securing a maximum possible sensor coverage in the maritime jurisdiction at the times of peace and war, and form a near real time like surface picture to ensure more efficient patrol and search-rescue operations in four seas, so that it would be possible to enhance the level of collaboration with the other public entities. The project goal is make it possible to perfectly and efficiently monitor all the territorial waters and adjacent zones, and struggle with such crimes as trafficking, illegal immigration, fishery and maritime pollution.

The CSRS Project is expected to form an recognized Surface Picture by means of the fusion and identification of the system trace data through the Automatic Identification System (AIS) as received from the sensors installed in the Coastal Surveillance Stations in the Turkish Maritime Jurisdiction and the radars and systems of the public entities/organizations integrated with the Maritime Information System. The CSRS Project is an integrated project of wide coverage, on which the information produced by the Maritime Information System is mutually shared with many public entities/organizations. The following Figure 1 shows The Coastal Surveillance Radar System (CSRS) Project.

The system comprises of two networks, the Coastal Surveillance Data System (CSDS) and the Maritime Information System (MIS). For the information exchange between the Ankara Operation Headquarters, Identification and Monitoring Centres and the Coastal Surveillance Stations, CSDS will be used, while the identified Common Data Pattern defined on MIS will be essential for the Service Based Architecture to secure the information exchange among the civil/military public entities in line with the individual entity requirements and within the framework of the sharing rules. Following are the entities covered by MIS: the Coast Guard Command, the Ministry of Transportation, Maritime Industry and Communication, the Navy Command, the Ministry of Environment and Urbanization, the Ministry of Food, Agriculture and Husbandry, the Ministry of Customs and Commerce and the General Directorate of Meteorology.



Figure 1. The Coastal Surveillance Radar System (CSRS) Project

During the project, one operation centre, four identification and tracking centres and 11 coastal surveillance stations are equipped with radars, Electro-Optical (E/O) and other sensors for integration with the public entities through the CGRS software. The coastal surveillance stations act as local control stations, the tracking centres work as zonal control station and the operation centre behave as national control station. The hierarchical and distributed data processing are performed over these mentioned control stations [2].

1.1 The Purpose of the Project

The purpose of the project is to establish a maritime tactical picture with integration of enough radar coverage over the whole coastal line and utilizing the electro-optical and integrated state agencies information. It has the goal of increasing the efficiency of law enforcement and search & rescue operation agencies. The gathered information and fused data are publish with state agencies.

1.2 System Components

The operation center is connected with the identification & tracking centers (KİM) and the coastal surveillance station (CSS) dedicated network with sufficient security measures. The CSS are equipped with radar systems, E/Os (IR and TV) and communication equipment [6]. Figure 2 shows an equipment located on coastal surveillance station CSS.

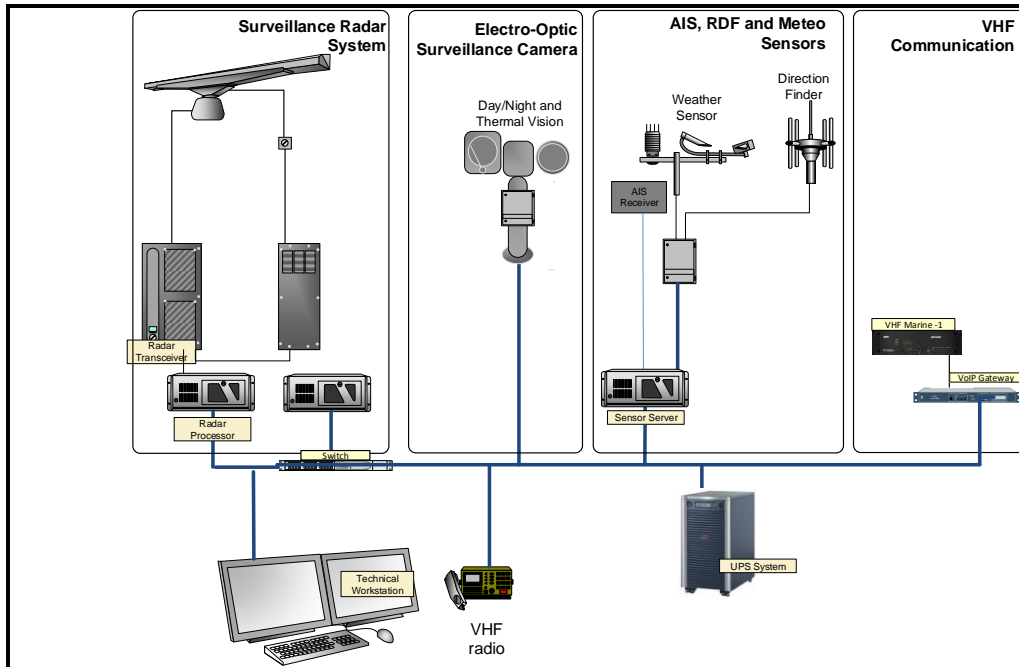


Figure 2. Equipment located on coastal surveillance station CSS

2. MAIN FUNCTIONS OF CSRS

The Coastal Surveillance Radar Systems software has the following functionalities.

2.1 Sensor Management Detection/Control

The Sensor Management Detection function is targeted to monitor the surface mobility in the coverage area of the sensors (Radar, AIS, E/O) located in the Coast Guard (CG) Stations and Traffic Surveillance (TS) Stations, which are designed as to be remotely controlled unmanned stations.

2.2 Data Fusion/Identification

The information received from the CGRS sensors and through MIS are fused to form the tactical seascape. The identification data received from the AIS's are used to automatically produce the identified seascape by insertion of identification data from E/O. The VTS software has a data fusion functionality for position calculation. The AIS and radar data are fused together to get the closest real position of ship, some track information must be visualized inside the system. Fusion process can be done two different ways, such as distributed (Location based) and centered (Sensor based) fusion. For distributed fusion 1st level fusion will be done at station between radar and AIS tracks. 2nd level fusion will be done at the center between station tracks. For centered fusion All AIS and Radar tracks will be processed at the center. Since the AIS source is the ship itself. The same data can be received from different sensors (station). The system drops if the same data comes another sensor. Fusion process will be done between only one AIS track and other radar tracks. This method increases center process, and center hardware capability.

2.3 Decision Support

The decision support function checks the element status information (location, local weather forecast, etc.) and the Coast Guard resource information for determination of the most appropriate resources, and provides the commissioning suggestions to the responsible advisor at the operation center.

2.4 Event Management

The event management function gives the capability to ensure the management of research/ rescue and other duties, and the determination of such planning as routing, element number, etc. It determines the most appropriate Coast Guard units that can intervene any event, and draw up and implement the operational plans.

2.5 Communication (Voice, VoIP) Control

The communication control function allows to manage VHF radio communication to ensure necessary coordination with the elements / targets in the field of interest and an interface to public telephone network.

2.6 Record and Replay

It provides a synchronized data store for the operators to make a post-event analysis of the sensor data and system information (including voice and video). The recorded data can be optionally archived on the external media through the operator software.

2.7 System Monitoring and Management

The monitoring of system equipment facilitates the system management, and increases the operational availability. It provides any necessary inputs for transfer of the resources of disabled centres into the standby centre. The status data of the equipment in the headquarters and stations are collected and monitored.

2.8 Stakeholder Entity Integrations

The currently available systems of the public entities to be integrated through MIS are included in the CGRS by means of the adapter software components.

3. CAPABILITIES & SPECIFICATIONS OF CSRS

Figure 3 shows a simple scenario of mission execution based on a reporting received. Upon receipt of a reporting about a sea vessel by phone call, e-mail or fax, or emergency calls from VHF and AIS of a sea vessel, the Operator examines the track created in the system for the maritime vessel if it is in the coverage area of radar and EO. The Operator uses EO sensor cameras that have the necessary coverage for the vessel to contribute to the identification of the track and to verify the reporting / call received. He can query the system related to the track and see the event history log about the vessel using the previously registered information in the system. For example, if the vessel is in the list of Suspicious Vessels in the system, it is more likely that the notification received is correct. If the vehicle is out of the range of the system sensors, the Operator initiates a track at the location reported in the system, and makes manual identification for the track using the EO sensors and notification information received through the call. The operator-initiated track is converted into a system track via fusion and correlation capability of the system in ITC and then it is sent to the MOC for global fusion and correlation by using additional information provided by other ministerial systems [1]. Finally, the track is included into the Recognized Maritime Picture. According to the type of the event information received via the call, the Operator may initiate a Task Planning or Search / Rescue Planning. The operator sends the plan to the patrol ships of the Coast Guard Command, which act as law enforcement agencies, through the CSRS communication infrastructure. When the CGC patrol received the task plan / order, it starts to execute the task plan and goes to the specified location and carries out the duties in the scope of the plan. Following the completion of the task, a report about the completion of the task plan/order, including necessary information, is prepared by the CGC patrol ship and sent to the ITM. The task result report is transferred to the CSRS database and the task is finalized.

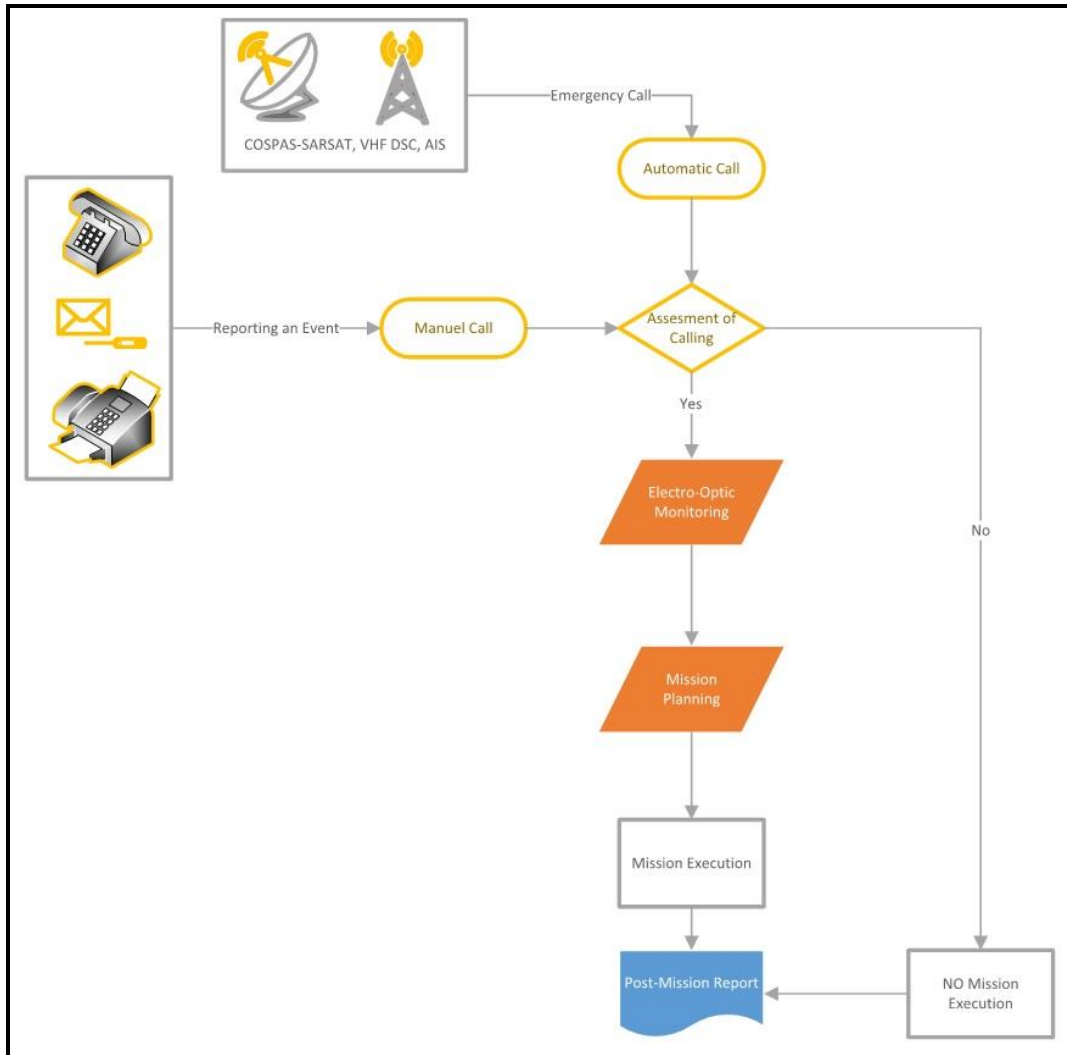


Figure 3. A simple scenario of mission execution based on a reporting received

Figure 4 shows the control system of the radars installed in the network and locations of vessel. All radars installed in this network use the same hardware configuration and software so that the appearance of the radar display will be the same. Some detected targets will be shown as small dots, large dots, and lines, which are depend on the shape and size of the targets similar to sea target recognition [3]. The Automatic Identification System (AIS) monitors the information sent by the ships such as ID, destination, type of cargo. This AIS is a supplementary to the radars. Figure 4 shows the display of this AIS with the Marmara Sea region in which the Turkish Straits Vessel Traffic Services radars are also integrated [4][5].

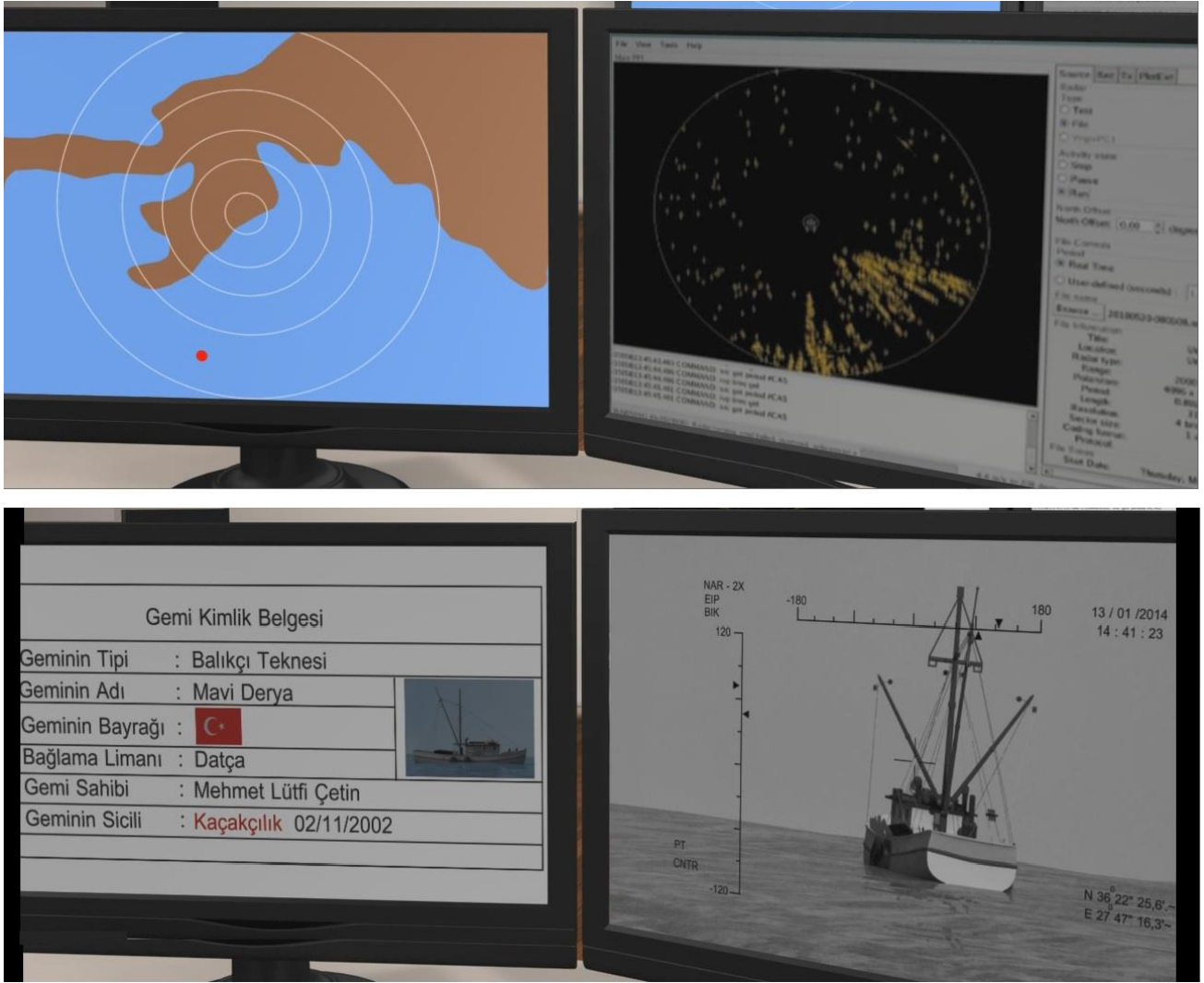


Figure 4. Displays of CSRS Application Software

4. CONCLUSION

Systems of Systems projects as in this paper a brief layout given CSRS technology should be used. The Coastal Surveillance Radar System (CSRS) provides situational awareness with adequate radar coverage of the coasts, territorial waters and exclusive economic zones of Turkey. The CSRS aims to increase cooperation level of public institutions and organizations in charge of coastal areas of Turkey, and enhance efficiency of reconnaissance, patrol, and search and rescue activities. With CSRS, Turkish Coast Guard will be able to deal much more decisively with smuggling, illegal immigration, fishing and sea pollution.

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